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PRESUMED TAXODIACEOUS FOSSILS FROM THE PALEOGENE OF ST. LAWRENCE ISLAND, ALASKA*

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Summary

A collection of Paleogene plants reputed to contain distichous short shoots of *Taxodium* and *Metasequoia* (Taxodiaceae) has been studied. The evidence to support this view is weak and it appears that if a genus of the Taxodiaceae is involved, *Sequoia* is the most likely. A number of other gymnospermous genera, both within and without the Taxodiaceae, could have produced these shoots but there is no clear evidence to decide which one of them. These plants are referred to *Elatocladus* Halle, a form genus for sterile coniferous and taxad shoots.

In 1960, Sveshnikova and Budantsev described a new species of *Taxodium, T. balticum* (Sveshnikova and Budantsev 1960; see also Sveshnikova 1963), from Oligocene strata of the Kaliningrad Peninsula. Subsequently, *T. balticum* was also discovered in Eocene strata in Germany (Mai and Walther 1969). This species is of interest from an evolutionary point of view, because the seed-scale complex of each female cone scale is conspicuously appendaged, and the bract of each cone scale is a prominent structure. Thus it differs from Recent *Taxodium* where these structures are significantly reduced (e.g., see fig. 184 C of Pilger 1926). Instead, *Taxodium balticum* shows significant resemblances to the structure of the ancestral voltzian conifers (Permian to Jurassic), and to the more primitive taxodiaceous genera, *Cryptomeria* and *Glyptostrobus*. Because of the evolutionary implications of this discovery, it has seemed to me worthwhile to seek out early records of *Taxodium* so that the morphology of the specimens can be reconsidered in the light of the known structure of *T. balticum*. So far it has been possible to establish that a supposed Paleocene species of *Taxodium, T. olriki* (Heer) Brown, has been misassigned to the genus *Taxodium* (Cridland and Butala 1973). In this paper attention is turned to specimens from St. Lawrence Island, Alaska. These are from University of California, Museum of Paleontology (Berkeley) locality number 232. This is a collection made by Mason at Iveetok (Iviktook) on the coast, on the north side of the mouth of Fossil River at the southeast foot of the Kookoolgot (Kookooligit) Mountains on the central part of the north side of St. Lawrence Island. Specimens from locality 232 are reported as *Taxodium dubium* (Sternberg) Heer by Chaney (1951, p. 235). Chaney considered them to be of Paleocene age, but according to Wolfe (1972, p. 203; personal communication) they are of Oligocene age. In addition to *Taxodium dubium, Metasequoia occidentalis* (Newberry) Chaney is reported from the same locality by Chaney (1950, p. 228). For both species, Chaney simply reports unnumbered specimens from University of

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California, Museum of Paleontology locality number . Chaney did not select any of the specimens from this locality as separately numbered types (Schorn, personal communication). Through the courtesy of Dr. Wayne Fry, the entire collection from locality number 232, which was studied by Chaney, was loaned to me for investigation. The specimens now bear the numbers 20,835 - 20,941. They are preserved in a well-compacted, white, volcanic ash. They occur in the form of impressions, or alternatively, in the form of high-rank compressions. Presumably they were significantly altered during diagenesis. Consequently, although it has been possible to remove leaf and shoot fragments from the rock matrix by maceration in 48% hydrofluoric acid and to prepare transfers using Cridland and Williams' (1966) technique, it has not been possible to prepare cuticles showing epidermal features. Apparently, the cellular outlines were destroyed during diagenesis. Macerations in the usual oxidizing agents merely yield leaf fragments with no discernible micromorphology (W. S. U. macerations numbers 513, 534, 535, 557, 558, 622, 623). Likewise, examinations of leaf surfaces by reflected light under high-power magnification, the use of reflected phase contrast microscopy, fluorescence microscopy (according to the technique advocated by Aleksandrov and Sveshnikova 1956) and scanning electron microscopy have failed to reveal epidermal details.

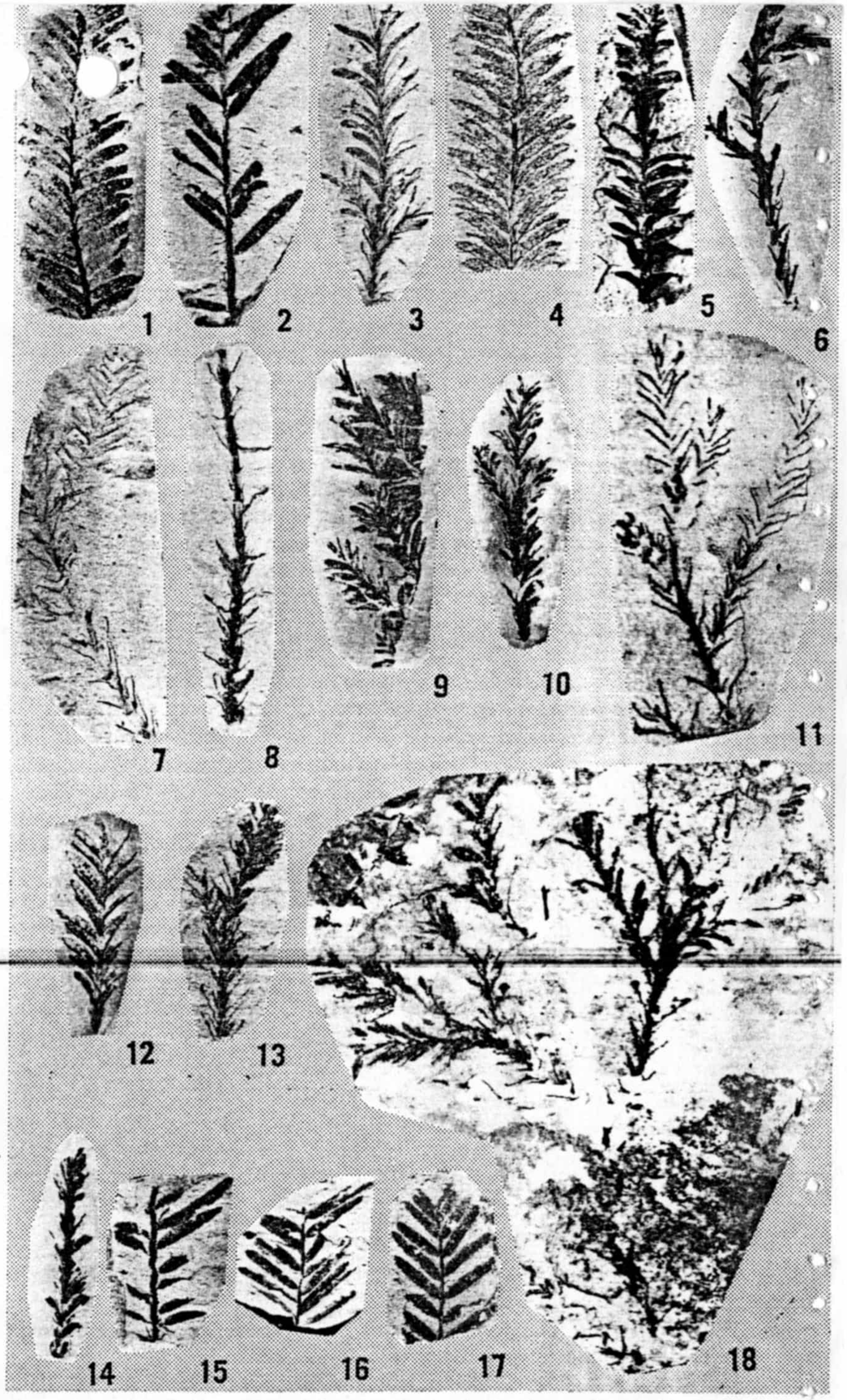
The collection from locality 232 contains approximately 200 specimens of coniferous shoots. Chaney considered them to represent two taxodiaceous genera, *Taxodium* and *Metasequoia*. The view that the Taxodiaceae are represented here is tenable, inasmuch as distichous foliage shoots are present. Nevertheless, in addition to the Taxodiaceae, flattened distichous foliage occurs in other coniferous genera and in the taxads (e.g., *Abies, Acmopyle, Amentotaxus, Cephalotaxus, Dacrydium, Keteleeria, Podocarpus, Saxegothaea, Taxus, Torreya, Tsuga).*

The specimens represented fall into the following categories

1. Shoots which are genuinely distichous. These bear broad alternately inserted needles, which may be closely or widely spaced (e.g., Pl. 1, fig. 1, 2, 4, 15, 16).
2. Shoots comparable to type 1, but in which the leaves are not as markedly distichous. The approach to the distichous condition may be reasonably close (e.g., Pl. 1, fig. 9), or the leaves may be only half twisted (e.g., Pl. 1, fig. 12). In one case a specimen looked perfectly distichous as exposed on the rock surface, but when transferred, many leaves were found to be projecting down into the matrix (Pl. 1, fig. 5).
3. A shoot comparable to type 1, but in which the leaves are oppositely to subopposite inserted (Pl. 1, fig. 17).
4. Shoots with spirally arranged leaves. The leaves on these shoots are closely spaced and are either needlelike or somewhat acicular (e.g., Pl. 1, fig. 6-8, 11, 14).
5. Shoots with spirally arranged leaves which give rise to distichous shoots. (Pl. 1, fig. 3, 10, 13, 18).

Interpretation

It is possible that several gymnospermous genera are represented in the collection. Nevertheless, enough interconnections of different shoot types have been demonstrated to suggest the strong probability of all the gymnospermous shoots belonging to the same genus, or species. If comparison is restricted to the Taxodiaceae, the genus *Sequoia* seems to be the most likely



Figs. 1–18. *Elatocladus* Halle, Paleogene, Iveetok, St. Lawrence Island, Alaska. All XI. 1, 20,869. 2, 20,838. 3, 20,941. 4, 20,850. 5, 20,835. 6, 20,939. 7, 20,860. 8, 20,920. 9, 20,849. 10, 20,851. 11, 20,858. 12, 20,860. 16, 20,935. 13, 20,874. 17, 20,837. 15, 20,854. 14, 20,896. 18, 20,905.

genus involved. The range of shoot types demonstrated in this collection can be approximated in *Sequoia sempervirens*, although in the case of these fossils, because they do not show enough unambiguous details, no attempt is made to attribute them to any particular genus or species. Only one fossil can be discovered in the collection which could possibly represent *Metasequoia*. This is specimen 20,837 (Pl. 1, fig. 17), where the leaf arrangement is apparently subopposite to opposite. The preservation of this fossil is too poor to allow detailed study of the leaf insertion, but it is clear that some leaf "pairs" are subopposite rather than opposite. Moreover, this fossil is the apex of a shoot and the leaves may appear to be opposite because the internodes are not fully expanded. My evaluation is that any claim for the presence of *Metasequoia* which had to be based upon this fossil would be extremely tenuous.

Evidence for the presence of *Taxodium* in this collection is also slender. It is possible to interpret a number of the distichous shoots as *Taxodium*, but the fact that a number of distichous shoots are attached to twigs bearing spirally arranged leaves of sequoian aspect detracts from this view. Also, the needles are of more robust stature than is usual in Recent specimens of *Taxodium*. In the fossils, typical leaf measurements are: 9.5 mm × 1.5 mm (Pl. 1, fig. 16), 12 mm × 2 mm (Pl. 1, fig. 2), 12.5 mm × 1.6 mm (Pl. 1, fig. 15); while in *Taxodium distichum* comparable measurements are: 17 mm × 0.6 mm, 14 mm × 1,1 mm for large leaves. In these fossils I can discern no details which will allow accurate identification of the genus. Chaney (1951, p. 177-179) cites features of leaf insertion which may be used to separate *Taxodium* and *Sequoia*, but it has been my experience that unless one is dealing with unusually well-preserved impressions or compressions, these are of little practical value. They are of no value in this particular case. The cuticular details which can be so valuable in distinguishing the genus *Taxodium* (Bandulska 1923, Florin 1931, Henry and McIntyre 1962, Sveshnikova 1963) cannot be discerned. There are no associated reproductive structures in the collection which would give a guide to generic identity. Although it is probably the case, one cannot be certain that the fossils can indeed be attributed to the Taxodiaceae. In these circumstances, the identification of any of these fossils with the genus *Taxodium* would be of little practical value. Such an identification must be regarded as possessing a very low value of probability of correctness. Before these fossils can be used in any discussion of the ancestry of *Taxodium*, additional positive evidence must be presented. For the present, it seems best to refer these specimens to the genus *Elatocladus* Halle (1913). This is a form genus for sterile coniferous and taxad shoots (Seward 1919, Wesley 1956). There appears to be no useful purpose in attempting to assign a specific name to these imperfectly known specimens.

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